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BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

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THE SOUTH ICE CAVE FIRE

A study of effects of fire in ponderosa pine forests

Contribution to a Cooperative Study

by

F. P. Keen
Forest Insect Laboratory
445 U. S. Court House
Portland, Oregon

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THE SOUTH ICE CAVE FIRE
A study of effects of fire in ponderosa pine forests

A Contribution to this Cooperative Study

by
F. P. Keen
Senior Entomologist
Bureau of Entomology and Plant Quarantine

Forest Insect Laboratory
445 U. S. Court House
Portland, Oregon
July 30, 1943

FOREWORD

The South Ice Cave fire of August 29, 1915, covered approximately 10,000 acres of ponderosa pine forest in the Cabin Lake District of the Deschutes National Forest, Oregon.

Following this fire, M. L. Merritt, who was then Supervisor of the Deschutes National Forest, conceived the idea of starting a study of the effect of fire in ponderosa pine stands - a subject of perpetual controversy. With the help of W. O. Harriman, who was then Ranger of the Fort Rock District, three plots of 100 trees each were established in this burn, representing light, medium and heavy burning. Each tree four inches in diameter and over was tagged with a metal tag and records taken as to diameter, portion of foliage browned and bole blackened, age of tree, type of crown, fire scars, etc. Subsequently at frequent intervals these trees were reexamined and notes taken as to recovery, number of trees that died and effect of fire on general stand conditions.

The last examination of these trees was made at Mr. Merritt's suggestion as a cooperative undertaking. A research party consisting of M. L. Merritt, Chief of Operations in the Regional Office; W. O. Harriman, Supervisor of the Fremont National Forest; T. H. Burgess, Supervisor of the Deschutes National Forest; G. D. Pickford, in charge of range research and E. L. Kolbe, pine silviculturist, both of the Pacific Northwest Forest and Range Experiment Station and the writer visited the area from April 25 to 30, 1938, and conducted a joint study of present conditions on the burned area.

Following this an outline was prepared by Mr. Merritt, covering all phases of the fire, and various sections were assigned to the research men covering their respective fields. The effect of fire on tree growth rates, on crown classes, and on insect losses within the area was assigned to the writer as well as a section on past-fire history of the region as shown by existing records and by fire scars. These phases of the fire study are covered in the present report.

PAST FIRE HISTORY OF THE REGION

The history of the pine forests on the Cabin Lake Area, like all other parts of the ponderosa pine region, is one of repeated forest fires, occurring at irregular intervals and affecting different portions of the stand in different years. Fire scars on the oldest trees show that forest fires were common hundreds of years ago, and that the forest never escaped repeated burning for any long interval of time.

This history of repeated burns is clearly shown both by the written records of known fires since 1908, and the toll-scale scars which earlier fires have left in the tree ring history.

A. Known fires.

Forest Service fire reports are the best source for a record of fires since 1908, when these reports were started on the Deschutes National Forest. The extent to which the Cabin Lake area has been covered by fires since 1908 is shown on the accompanying map by ten-year intervals. The total acreage burned and volume killed as shown by the Deschutes fire records is shown in Table 1.

Table 1. Fire History of the Cabin Lake Area, Deschutes National Forest, Oregon.

Decade	Acreage Burned	Volume Killed M.bm.	Volume Killed per acre burned
1908 - 1917	46,481	297,735	6,400
1918 - 1927	22,386	257,612	11,500
1928 - 1937	1,844	2,788	1,510
Total in 30 years	70,711	558,135	7,900
Estimated total original stand	306,600	3,066,000	10,000
Percent burned	23.0%	18.2%	
Percent burned per yr.	0.77%	0.61%	

This record speaks well for the efficiency of fire control, for the acreage burned has dropped steadily since the area was put under protection. For acreage burned, losses were heaviest during the decade 1918-1927, which in part may be accounted for by drought conditions prevailing during this period.

At the rate at which fires were covering the area in the first decade, the forest would be expected to burn over completely once every 6.6 years. At the rate covered in the last decade, only 0.54 percent of the area was burned per year.

It is interesting to note that of the total acreage burned in the last thirty years, only 4,660 acres or 6.6 percent was so badly injured as to be classed by the Forest Survey as "denuded and not restocking."

Exclusive of these denuded areas, the Forest Survey shows a stand volume in 1934 of:

9,200 board feet per acre on 9,020 acres burned in 1915 and 1917, and 9,050 board feet per acre on 6,840 nearby acres unburned since 1908.

It is, of course, impossible to say how much timber would have been on these areas if fires had always been excluded, but at least the present difference is not a striking one.

The loss in stand volume on burned areas averaged 0.61 percent of the board foot volume per year. This is slightly less than the estimated growth rate of 0.67 percent of stand volume per year in this type. At this rate, the fire loss almost balanced growth.

B. Fire Scar Data.

The occurrence of old fires can be very definitely established and dated by means of the healing tissue which forms at the margins of fire scars. The date of the fire can be determined roughly by chopping out a wedge-shaped chunk of wood on the edge of old cat-faces and counting the rings. But because of the frequency of missing rings, especially on the edge of wounds, the dating must be verified by cross-identification of the ring pattern in the wood laid down before the fire occurred. Often the fire date can be further verified by the occurrence of a small ring immediately following the fire year, or a series of small rings if the tree was severely defoliated. Accurate dating of fire scars rarely can be done in the field with the naked eye or even with a powerful hand-lens, but sections must be examined under a microscope and the ring pattern cross-identified with a well established master pattern.

Some 22 plots, with five or more fire-scar chips from each plot, scattered throughout the Cabin Lake area have been studied to establish the dates of old burns. Even with this rather extensive sampling, the evidence is not sufficient to delineate the boundaries of any old burns - only their general extent and severity.

Just as with fires since 1908, some early fires were quite restricted as to area, others widespread. Some small ones were very severe, as judged by the effect upon growth rates; others apparently did little damage.

In the period before 1908, fires occurred somewhere on the Cabin Lake area nearly every year. A few of these were evidently of large extent and of major importance.

Going back over the fire scar evidence, we find that a large part of the country from T. 23 S; R. 11 E. to T. 23 S.; R. 15 E. was covered by a forest fire in 1905. This is included in the shaded area on the accompanying map. Reports of this fire are recalled by some of the early foresters in the region.

Other large fires occurred in 1888, 1883, 1869, 1863, 1845, 1838, 1824 and 1792 as indicated by numerous fire chips. Few chips were taken deep enough to tell anything about the frequency of fires before 1800. The record on this point is covered, however, by the study of stump sections from the nearby Watkins Butte area, which clearly indicates repeated fires back as early as 1352.

On the small area covered by Plots #2 and #3 of the South Ice Cave fire study, early fires during the period 1800 to 1915 were established by fire scar records and ring pattern. These occurred in 1905, 1883, 1869, 1855, 1845 and 1829. None of these fires with the exception of the one in 1829 caused serious defoliation or stoppage of growth. The 1829 fire must have been as bad as the one in 1915 for many trees showed the effect of severe defoliation, a sudden stoppage of growth, and in many cases several years of missing rings.

Influence of Fire on Rate of Growth.

A series of increment cores, 154 in all, two per tree, one on the northeast side and one of the southwest, was taken from all the surviving numbered trees on the three sample plots, and from 99 trees outside the burn in order to determine what the effect of the fire had been on growth rates. These cores were then measured by years and decades.

(a) Effect of fire on growth according to side of tree.

In order to see whether there was any difference in growth according to side of tree, 70 pairs of radial increment cores were compared. As the fire travelled from the southwest towards the northeast and there was considerable difference in the amount of crown damaged on these two sides of the trees, it was thought that these two sides would show the greatest difference in radial growth if there was any such difference due to this injury. The results of this comparison are shown in the following Table, #2.

Table 2. Effect of fire on growth according to side of tree.

Side of tree	No. of trees	Average growth before fire 1891 - 1915 mm. per decade	Average growth after fire 1916 - 1937 mm. per decade	Percent reduction %
North and East	70	10.60	5.00	53
South and West	70	10.40	4.95	52.5

It is evident that the differences in the averages are so slight as to be insignificant. In some trees there was a striking difference, especially where trees had been badly burned on one side and not on the other, but there was not enough consistency in this occurrence on the same side of trees to show up in the averages.

(b) Effect of fire on trees of different sizes.

Trees within the burn were compared as to radial growth reduction according to tree diameter groups. The results are shown in Table 3.

Table 3. Effect of fire on trees of different sizes.

Tree Group D.B.H.	Number Increment Cores	Average growth before fire 1891 - 1915 mm. per decade	Average growth after fire 1916 - 1937 mm. per decade	Percent reduction %
5 to 11 inches	34	12.8	5.4	58
12 to 17 inches	45	12.5	5.9	53
18 to 23 inches	37	9.0	3.9	57
24 to 29 inches	27	8.9	4.2	53
30 to 37 inches	11	7.4	3.7	50

The average reduction for all burned trees was 55 percent. Trees of the smaller diameters appear to have been affected the most, with the larger trees affected the least; but the difference of from 50 to 58 percent reduction is not large enough to be strikingly significant.

(c) According to rate of growth before the fire.

First trees were grouped according to their rate of growth before the fire into four general groups as follows:

Group 1 - Radial growth 15 mm. or more per decade.
Group 2 - Radial growth 10 - 15 mm. per decade.
Group 3 - Radial growth 5 - 10 mm. per decade.
Group 4 - Radial growth less than 5 mm. per decade.

Chart No. 1

COMPARISON OF DECADAL GROWTH OF TREES ON BURNED AND UNBURNED PLOTS ARRANGED BY FOUR VIGOR CLASSES

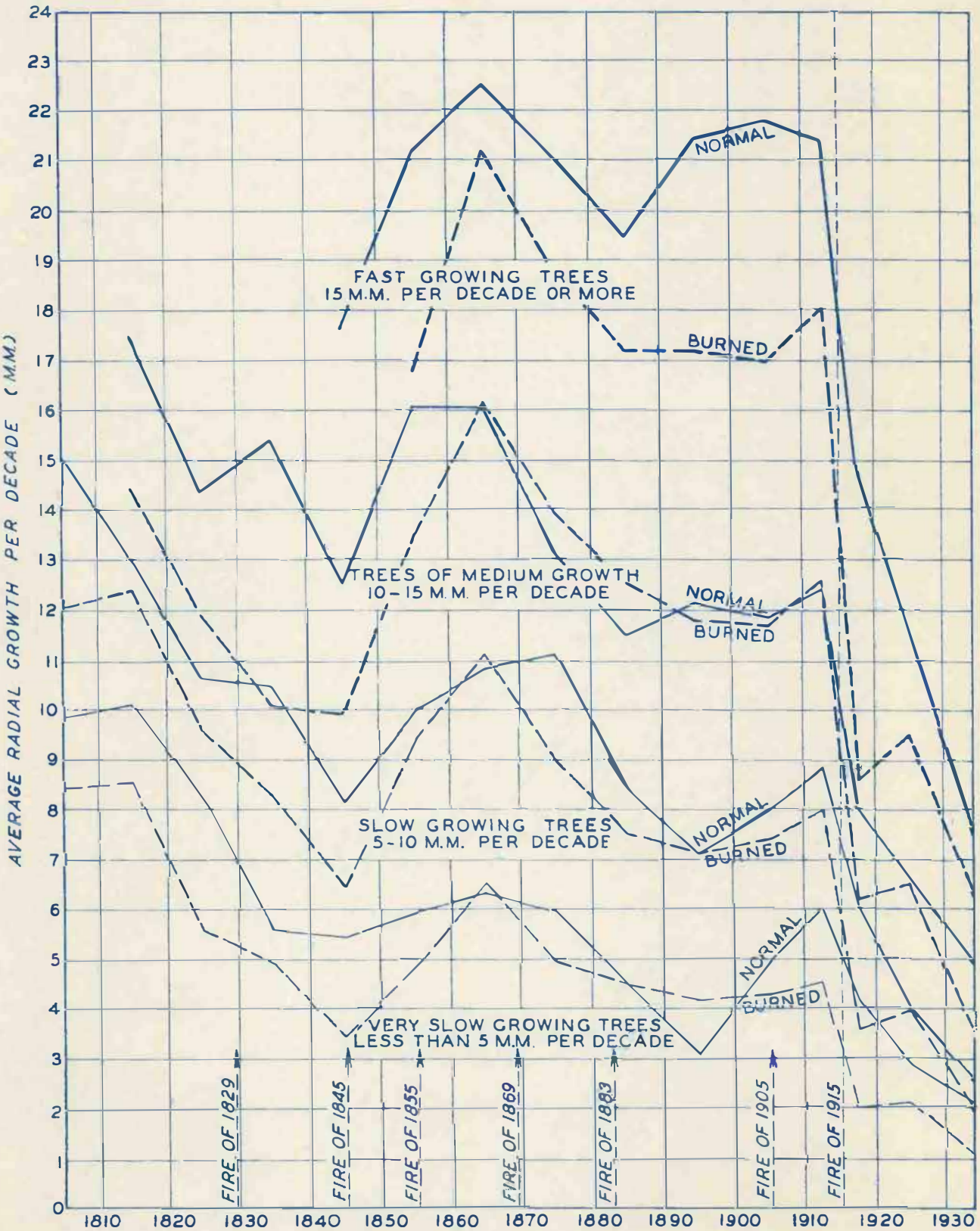


Chart 1 shows that following the 1915 fire there was a sudden reduction in growth in all groups, not only in the burned trees but in the normal unburned trees, so that the difference between these two groups was not striking. The chart also shows some apparent effect of previous fires, yet in every case the fluctuations are quite similar to the general pattern of tree growth due to climatic factors. The slow growth between 1840 and 1850 for instance is common to all areas in eastern Oregon and evidently is due to drought rather than fires.

Table 4. Comparison of growth before and after 1915 burn according to growth rates before the fire.

	Av. Growth Before Fire (1891-1915)		Av. Growth After Fire (1916-1937)		Reduction Percent	
	Burned*	Unburned	Burned	Unburned	Burned	Unburned
	mm. per decade		mm. per decade		Percent	
Group 1	17.2	21.5	8.3	11.2	52%	48%
Group 2	11.9	12.1	5.4	6.4	55	47
Group 3	7.5	7.8	3.2	4.0	57	49
Group 4	4.4	4.4	1.8	3.0	59	33

* Burned afterwards in 1915

Comparing the actual measurements of these four groups of trees, (Table 4), we find that all except the slowest growing trees suffered approximately 48 percent reduction in growth in the 22-year period 1916 - 1937 due to drought conditions. Trees on the South Ice Cave burn showed an average reduction of about 55 percent. The difference of about 7 percent, therefore, may be attributed to the effect of the fire.

Another point is evident in Table 4, for it appears that the faster growing trees before the fire suffered somewhat less than the more slowly growing trees. There is a 7 percent difference between Group 1 and Group 4.

(d) Effect of Crown Damage on Growth Rates.

Previous studies 1/ have shown that growth is roughly proportional to the amount of crown.

1/ Dunning, D. 1922. Relation of crown size and character to rate of growth and response to cutting in western yellow pine. Jour. For. 20: 379-389.

On the South Ice Cave burn, many trees with heavy defoliation or crown injury died following the fire; but of the survivors, growth rates were affected as shown in Table 5.

Table 5. Effect of Crown Damage on Growth Rate of Surviving Trees.

Tree Group	Number Increment Cores	Average growth before fire 1891 - 1915 mm. per decade	Average growth after fire 1916 - 1937 mm. per decade	Percent reduction %
Check trees outside of burn	99	13.5	7.1	48
Crowns browned 25% or less	44	9.4	5.0	47
Crowns browned 33% to 50%	28	12.8	6.5	49
Crowns browned 66% to 75%	31	10.7	4.7	56
Crowns browned 80% to 100%	51	10.7	3.8	64
Average for all burned trees	154	10.7	4.8	55

Check trees outside the burn showed a 48 percent reduction in average decadal radial growth in the twenty-one years following the fire as compared with the previous twenty-five years. In crowns browned 25 percent or less or from 33 to 50 percent there was practically this same normal reduction in growth. But in trees browned from 66 to 75 percent, an increased reduction of 8 percent was observed; while in surviving trees browned from 80 to 100 percent, a 16 percent additional reduction occurred.

The effect on the growth pattern is best illustrated by comparing the annual growth rates and patterns in these various groups of trees as shown in Chart 2. Trees from 80 to 100 percent defoliated showed an average reduction in growth of 90 percent immediately following the fire; then their growth gradually improved until nine years later it was following the general pattern as predominantly influenced by climate, but never quite got back to the level of normal trees. Trees from 66 to 75 percent defoliated showed an 80 percent average reduction in the first year following the fire and took six years to get back to normal. Trees less than 50 percent defoliated took about three years to recover.

One of the striking points illustrated by this chart (No. 2) is that the normal growth pattern as affected by climate was little disturbed by the fire, except for approximately nine years immediately following the fire, even on those trees most severely affected. Nor was there any stimulation of growth due to release from competition on the burned area. (This is in contrast to other burns studied which show definite release in reserve trees surviving fires.) The reduction in growth rate following 1915 was similar on both burned and unburned areas and there was no lasting differential effect on growth either beneficial or detrimental in character.

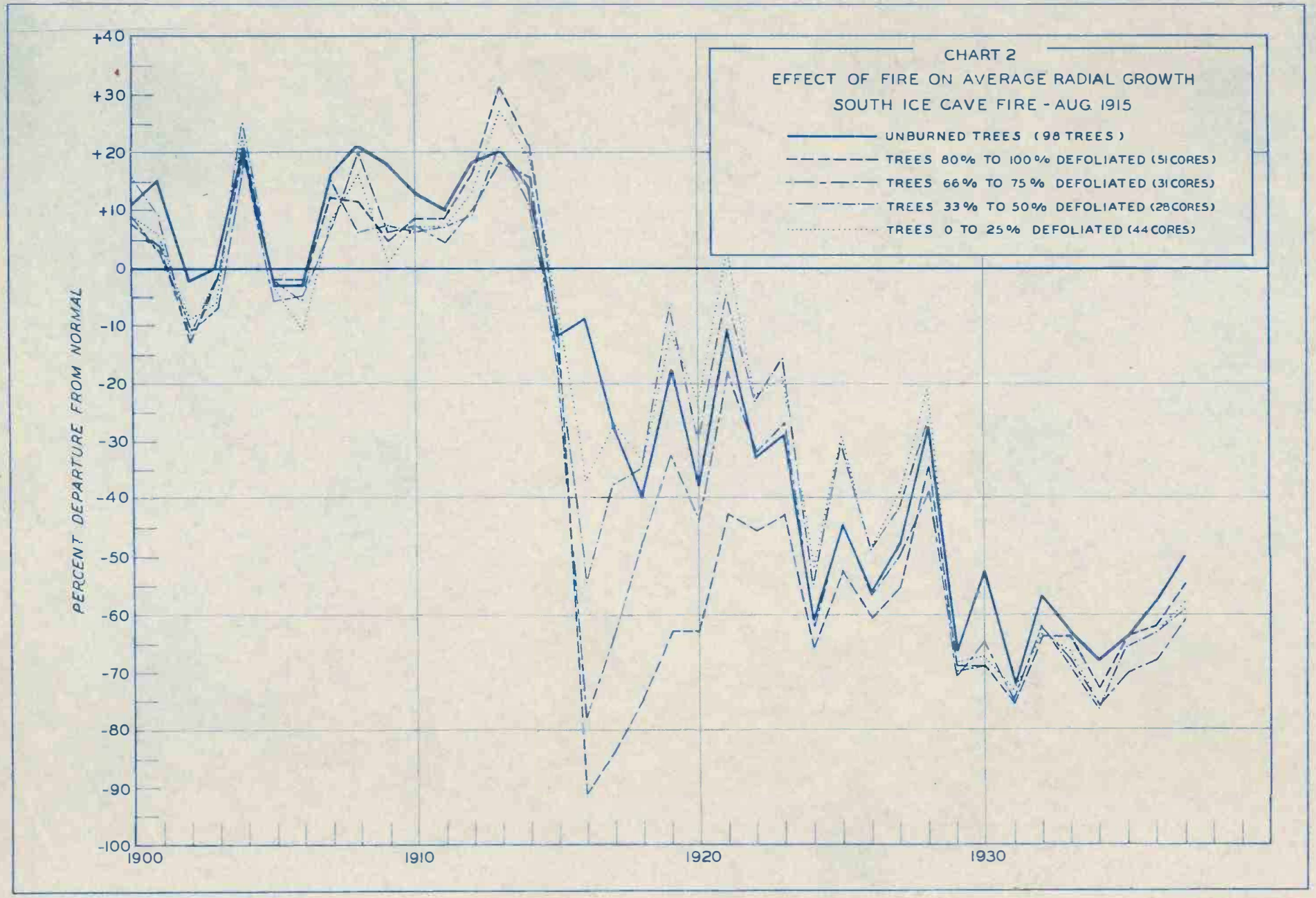


CHART 2
EFFECT OF FIRE ON AVERAGE RADIAL GROWTH
SOUTH ICE CAVE FIRE - AUG. 1915
UNBURNED TREES (98 TREES)
TREES 80% TO 100% DEFOLIATED (51 CORES)
TREES 66% TO 75% DEFOLIATED (31 CORES)
TREES 33% TO 50% DEFOLIATED (28 CORES)
TREES 0 TO 25% DEFOLIATED (44 CORES)
PERCENT DEPARTURE FROM NORMAL
+40
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1900
1910
1920
1930

(e) Missing Rings.

When trees are defoliated by fires or insects, it is not at all uncommon for them to fail to put on annual growth rings in the lower bole. The number of missing rings appears to be dependent upon the amount of crown destroyed, as indicated by the following table.

Table 6. Frequency of Missing Rings in Trees According to Fire Damage.

% Crown Defoliation	Growth too slow to measure	Number of Cores with Missing Rings: None	1	2	3	4	No growth since 1915	Total	Total in Class	% Total in Class
0 - 25%	2	38	2	1				3	43	7.0
33 - 50%	2	22	4	1				5	29	17.3
66 - 75%	5	15	9	1				10	30	33.3
80 -100%	9	9	16	9	4	2	3	34	52	65.5
Total	18	84	31	12	4	2	3	52	154	33.7

The greater frequency of occurrence of missing rings in trees of poor vigor is also indicated by the grouping in Table 7.

Table 7. Frequency of Occurrence of Missing Rings in Trees of Poor Vigor.

Crown Vigor Class*	Growth too slow to measure	Number of Cores with Missing Rings: 0	1	2	3	4	22	Total Cores with Missing Rings	Total in Class	Percent of Total
A	0	25	1	2				3	28	10.7
B	6	33	10	3	2	2		17	56	30.4
C	4	21	12	5	1		2	20	45	44.4
D	8	5	8	2	1	0	1	12	25	48.0
Total	18	84	31	12	4	2	3	52	154	33.7

* As classified in 1938, 23 years after the fire.

Out of the 72 trees on the burn from which increment cores were taken, 15 trees showed 1 missing ring immediately following the fire; 6 showed 2 missing rings; 2 showed 3 missing rings; 1 showed 4 missing rings and 1 showed no growth since 1915. This last tree was of particular interest. The record showed it was a young vigorous tree (probably a 1A or 2A) which had been "crowned out" by the fire. The following year it was listed as "dead." Then in subsequent years it showed signs of life, first with a small tuft of green needles at the top and later by developing a small crown. Apparently all of the growth went into building this top and no surplus was available to add radial growth to the lower trunk. This tree with 22 missing rings is a new record in my experience with ponderosa pine tree growth.

(f) Effect of fire intensity on radial growth.

At the time of the fire, three 100-tree plots were established in light, moderate and heavy burns. It is, therefore, of interest to compare the growth rates following burns of different intensity as compared with unburned surrounding areas. This comparison is shown in Table 8.

Table 8. Effect of Fire Intensity on Growth Rate of Surviving Trees.

Tree Group	Number Increment Cores	Average growth before fire 1891 - 1915 mm. per decade	Average growth after fire 1916 - 1937 mm. per decade	Percent reduction %
Check trees outside burn	99	13.5	7.1	48
Light burn	40	10.8	6.0	45
Moderate burn	32	10.5	5.1	52
Heavy burn	5	8.8	3.7	58

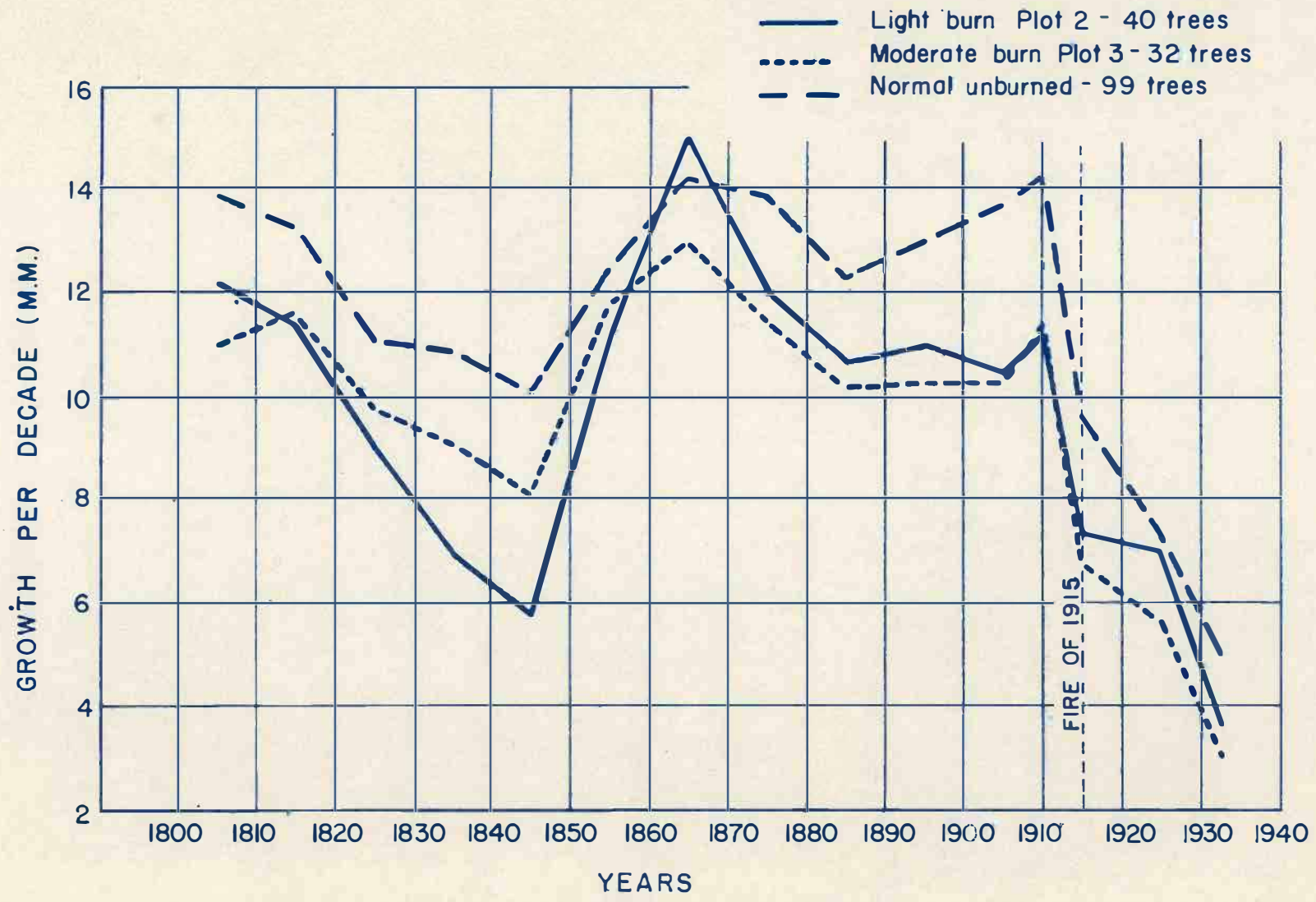
The comparative growth by decades for light, moderate and normal areas is shown graphically in Chart No. 3. From these comparisons, it is evident that there are only slight differences in growth reduction regardless of the intensity of the burn. Such slight differences as do occur indicate that the heavier burns had greater subsequent growth reductions, but that the lightly burned area had somewhat less reduction in growth than the surrounding areas.

Comparison of Mature Stand Conditions on and off Burn.

In order to compare the general condition of the present stand on the burn with conditions in neighboring unburned stands, three half-section plots were selected within the South Ice Burn and three similar plots outside this burn. These plots were cruised for present stand

Chart No. 3

EFFECT OF FIRE INTENSITY ON AVERAGE RADICAL GROWTH OF TREES LESS THAN 50% BURNED SOUTH ICE CAVE FIRE - AUG. 1915



volume, stand structure (distribution of trees within tree classes) and recent insect losses. It so happened that the three plots within the burn had been previously selected and cruised in connection with the annual regional pine beetle survey. The great difficulty was in finding comparable neighboring unburned plots, for practically all of the adjacent country had been covered with fires at least since 1905. The comparison, therefore, resolved itself into comparing conditions on the South Ice Cave Burn of 1915 with conditions on earlier burns. After cruising, one of the plots was found to have been within the boundaries of the 1917 burn.

The six plots selected for this comparison were as follows:

Within the South Ice Cave Burn of 1915:

Sixteen Butte Plot	- T.23S.; R.15E. Sec 8-W½	320 acres
Horseshoe Butte Plot	- T.23S.; R.14E. Sec 24-E½	320 acres
Dead Log Butte Plot	- T.23S.; R.15E. Sec 18-W½	320 acres

Outside the South Ice Cave Burn.

Poly Top Plot	- T.23S.; R.14E. Sec 1-W½	320 acres
Wig Top Butte Plot	- T.23S.; R.15E. Sec 22-E½	320 acres
Steigleder Plot	- T.23S.; R.14E. Sec 27-S½	320 acres

A comparison of number of trees by 320-acre (half section) plots inside and outside the 1915 burn was as follows:

Inside the Burn		Outside the Burn	
Plots	Total trees	Plots	Total trees
Sixteen Butte	5,290	Poly Top	7,030
Horseshoe	3,630	Wig Top	6,200
Dead Log	5,220	Steigleder	4,670
Total	14,140	Total	17,900
Trees per acre	15		19

It is evident from the above that on the average more trees per acre were found outside of the burn than within.

A comparison of the volume on these same 320-acre (half section) plots gave the following results.

Inside the Burn		Outside the Burn	
Plots	Total volume	Plots	Total volume
Sixteen Butte	3,807,400 bd.ft.	Poly Top	1,698,200 bd.ft.
Horseshoe	2,118,700 bd.ft.	Wig Top	2,782,500 bd.ft.
Dead Log	2,683,100 bd.ft.	Steigleder	3,117,600 bd.ft.
Total	8,609,200 bd.ft.	Total	7,598,300 bd.ft.
Volume per acre	8,960 bd.ft.		7,800 bd.ft.
Volume per tree	610 bd.ft.		420 bd.ft.

The above shows that while there were more trees on the plots outside of the 1915 burn, the volume per acre was higher on the burn; because trees were of larger size averaging 610 board feet per tree, as compared with 420 board feet per tree for trees on the outside.

Distribution by Tree Class.

The difference in stand structure between plots on the burn as contrasted with those outside also brings out the fact that on the burn the trees ran to older age classes, while outside the burn there was a higher proportion of young trees in age classes 1 and 2. Table 9 gives this comparison which is illustrated graphically in the accompanying Chart No. 4.

The difference in stand structure indicates that on the burn 39 percent of the stand volume was in trees of beetle susceptible classes (C and D and 4D), while outside the burn 21.2 percent of the volume was in such classes.

Insect Losses on and off the 1915 Burn.

At the time the cruise was made (1937 and 1938) on these six 320-acre plots, a count was made of snags and down trees. Most of the fire-killed trees had fallen, so the results show a comparison of insect kill during the past 10 to 15 years after the immediate effects of the fire had disappeared. The results were as follows:

Inside the Burn			Outside the Burn		
Plots	Snag Volume	Percent Stand	Plots	Snag Volume	Percent Stand
Sixteen Butte	596,900	13.5	Poly Top	798,000	32.0
Horseshoe	811,100	27.7	Wig Top	1,277,400	31.5
Dead Log	991,400	27.0	Steigleder*	401,900	11.4
Total	2,399,400	21.8		2,477,300	24.7

* Partly in 1917 burn

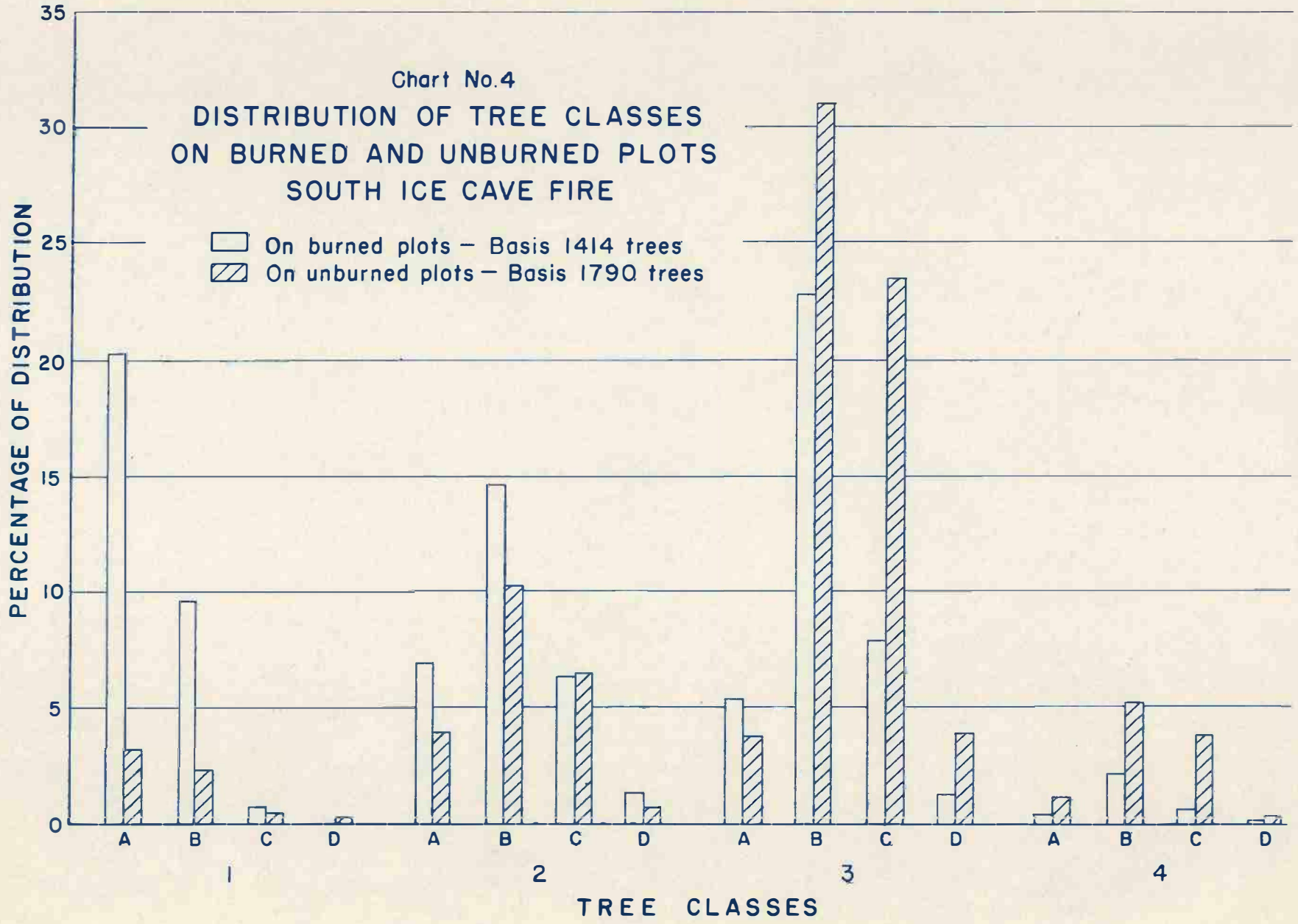


Chart No.4
DISTRIBUTION OF TREE CLASSES
ON BURNED AND UNBURNED PLOTS
SOUTH ICE CAVE FIRE
On burned plots – Basis 1414 trees
On unburned plots – Basis 1790 trees
PERCENTAGE OF DISTRIBUTION
35
30
25
20
15
10
5
0
A B C D A B C D A B C D A B C D
1 2 3 4
TREE CLASSES

As the above table shows, the total snag volume as well as percent of stand killed was slightly higher outside the burn than on the 1915 burn. The loss outside the burn would have been considerably higher had it not been for the Steigleder plot which was partly in the 1917 burn and showed a very low loss.

A check was also made of the current 1937 beetle damage with the following results:

Inside the Burn			Outside the Burn		
Plots	Snag Volume	Percent Stand	Plots	Snag Volume	Percent Stand
Sixteen Butte	12,540	0.33	Poly Top	46,710	2.67
Horseshoe	17,030	0.80	Wig Top	22,145	0.79
Dead Log	23,765	0.88	Steigleder*	4,850	0.01
Total	53,335	0.61		73,705	0.96

* Partly in 1917 burn

The above shows a variable current loss with by far the heaviest loss occurring on the Poly Top Plot outside the burn and the least loss on the Steigleder plot which was within the 1917 burn. On the average the current loss was somewhat higher outside than inside the 1915 burn.

Adding the number and volume of snags and down trees to the present living stand (Table No. 9), we find that the original volume was somewhat higher on the burned plots than on the unburned, but that the number of trees was less.

Comparing the dead trees and volume to the original stand, we find that the percent of trees killed (26.5 percent) was much higher on the burned plots than on the unburned plots (19.9 percent); but the percent of volume killed was practically the same on both sets of plots (30.0 percent on burned plots - 29.8 percent on unburned).

The percent of snag volume loss is highest on unburned plots (22.9 percent as against 19.5 percent), while the percent of down trees is highest on the burned plots (11.0 percent on burned, against 4.8 percent on unburned).

Table 9. Distribution of Trees and Volume on Burned and Unburned Plots.

Tree Class	Burned Plots Total 960 Acres - 10% Cruised				Unburned Plots Total 960 Acres - 10% Cruised			
		Volume	Percent			Volume	Percent	
	Trees	Bd. ft.	Trees	Vol.	Trees	Bd. ft.	Trees	Vol.
1A	45	3,400	3.2	.4	362	21,170	20.2	2.8
1B	32	2,430	2.3	.3	172	6,070	9.6	.8
1C	7	380	.5	.0	12	320	.7	0.
1D	4	70	.3	.0	0	0	0.	0.
2A	55	22,110	3.9	2.6	123	45,590	6.9	6.0
2B	144	39,300	10.2	4.6	262	52,830	14.6	7.0
2C	90	11,150	6.4	1.3	113	13,470	6.3	1.8
2D	10	330	.7	.0	24	1,000	1.3	.1
3A	54	67,450	3.8	7.8	97	110,550	5.4	14.5
3B	439	352,460	31.0	41.0	407	338,850	22.7	44.7
3C	332	135,200	23.5	15.7	141	58,250	7.9	7.7
3D	55	5,900	3.9	.7	21	3,370	1.2	.4
4A	16	36,940	1.1	4.3	8	22,830	.4	3.0
4B	74	121,900	5.2	14.1	37	70,110	2.1	9.2
4C	54	61,270	3.8	7.1	10	14,670	.6	1.9
4D	3	630	.2	.1	1	750	.1	.1
Total	1414	860,920	100.0	100.0	1790	759,830	100.0	100.0
Total Snags	299	239,940	15.5*	19.5*	338	247,730	15.1*	22.9*
Down Trees	212	129,010	11.0*	10.5*	106	75,110	4.8*	6.9*
Total Dead	511	368,950	26.5*	30.0*	444	322,840	19.9*	29.8*
Total Orig.	1925	1,229,870	100.0	100.0	2,234	1,082,670	100.0	100.0

* Percent of original

Conclusions.

From this study of fire occurrence in the ponderosa pine forests of the Deschutes National Forest, Oregon, and its effect on growth rates and mortality from pine beetles, the following conclusions have been drawn:

(1) Fires have occurred repeatedly in the ponderosa pine forests of the Cabin Lake area, as far back as tree ring records in living trees can be traced.

(2) In the last thirty years since 1908, when fire records on the Deschutes Forest were started, 23 percent of the Cabin Lake area has been burned over with a loss of 18.2 percent of the stand or an annual rate of 0.77 percent of area and 0.61 percent of the stand volume. This is slightly less than the estimated annual growth of 0.67 percent of board foot volume per year. The amount burned per year has rapidly decreased with improved protection.

(3) The general effect of the fire, in trees which have survived, has been to reduce growth rates by about 7 percent over the normal reduction of 48 percent in the period 1916 to 1937.

(a) On the average there was no noticeable difference in the effect of the fire on growth rate according to side of tree.

(b) Growth of small trees was affected slightly more than those of larger diameter.

(c) Slow growing trees suffered more than fast growing trees.

(d) Trees with crowns browned less than 50 percent showed little effect from the fire in the 22-year period 1916-1937. Trees with crowns browned more than 50 percent either died or had their growth further reduced. Surviving trees with crowns browned from 66 to 75 percent showed 8 percent additional reduction in growth, while those browned from 80 to 100 percent showed 16 percent additional reduction in the period 1916-1937.

Trees less than 50 percent defoliated recovered their normal growth rate within three years, while trees more than 80 percent defoliated took about nine years on the average to recover normal growth, if they survived.

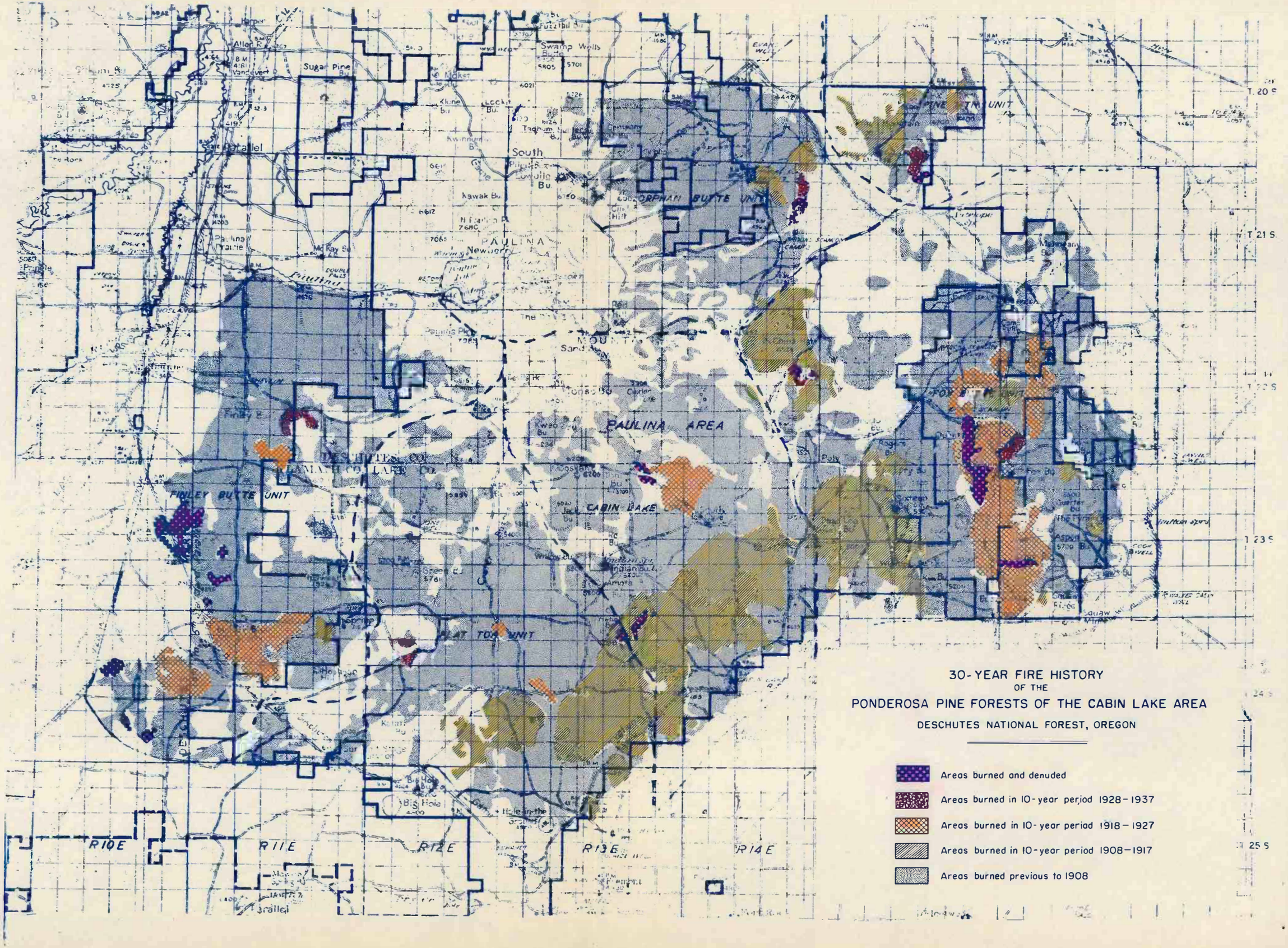
(e) With an increase in percent of crown defoliated, there was a corresponding increase in the number of trees showing missing rings. One living tree was found which had made no ring growth on the lower bole in the 22 years since the fire.

(f) Reduction in growth rates in the 22-year period following the fire increased slightly with the intensity of burn, except that lightly burned areas showed somewhat less reduction in growth than normal unburned areas.

Analysis of stand condition on the 1915 burn and in the surrounding areas indicated a larger number of trees per acre off the burn, but a larger volume per acre on the burn in trees of larger diameter and volume per tree. Stand structure analysis showed a dearth of younger age classes on the burn and with a higher percentage of trees in beetle-susceptible classes than in neighboring areas.

From a snag count and check of current 1937 pine beetle damage, a somewhat heavier loss of timber was noted outside the burn than inside but the variability between plots was too large to permit conclusive data on this point.

In general, it would appear from these results that on light and medium burn, this fire had its greatest effect in destroying the young stand of small size and volume; but that since the fire, pine beetles have taken a somewhat heavier toll outside the burn so that the total volume lost from both causes has been much the same on both burned and unburned plots. Now after twenty-two years there is a somewhat larger volume per acre but fewer trees on the burned area than on the unburned, but this difference is not so large as to be strikingly significant.



30-YEAR FIRE HISTORY
OF THE
PONDEROSA PINE FORESTS OF THE CABIN LAKE AREA
DESCHUTES NATIONAL FOREST, OREGON

- Areas burned and denuded
- Areas burned in 10-year period 1928–1937
- Areas burned in 10-year period 1918–1927
- Areas burned in 10-year period 1908–1917
- Areas burned previous to 1908